

26. Haseltine, Burton: Ionization in the Treatment of Nasal Hyperesthesia, Eye, Ear, Nose and Throat Monthly 13:257 (Aug.) 1934.

27. Jackson C., and Coates, G. M.: Diseases of the Nose, Throat and Ear. Philadelphia, W. B. Saunders and Company, 1929.

28. Hollender, A. R.: Physical Measures in Hypertrophic Rhinitis, Illinois M. J. 64:269 (Sept.) 1933.

29. Beck, J. C.: Pathology and Intramural

Coagulation of the Inferior Turbinate. Ann. Otol., Rhin. & Laryng. 39:349 (June) 1930.

30. Hollender, A. R.: Chronic Suppurative Otitis Media, Chronic Maxillary Sinusitis, Simple Chronic Laryngitis, Arch. Phys. Therap., X-Ray, Rad. 10:503 (Nov.) 1929.

31. Hollender, A. R., and Cottle, M. H.: Nasal Accessory Sinus Disease: A Survey of Available Treatment Methods with Special Reference to Physical Therapy, Illinois M. J. 52:106 (Aug.) 1927.

Intranasal Zinc Ionization — Its Fundamental Aspects and Clinical Value

A. R. HOLLENDER, M.D., F.A.C.S.

CHICAGO

Reprinted from the
Archives of Physical Therapy, X-Ray, Radium,
October, 1934, Vol. XV, pp. 581-587

INTRANASAL ZINC IONIZATION — ITS FUNDAMENTAL ASPECTS AND CLINICAL VALUE *

A. R. HOLLENDER, M.D., F.A.C.S.

CHICAGO

The successful treatment of aural and general surface sepsis with zinc ionization has suggested its potentialities in rhinologic practice. For the past ten years the medical literature has dealt rather liberally with this method, the consensus of opinion being sufficiently favorable to warrant a review of its fundamental and clinical aspects.

For intranasal treatment the galvanic current early was utilized for zinc electrolysis of the inferior turbinates. Recently Norrie⁽¹⁾ revived this treatment and claimed for it good results in reducing the size of the turbinate bodies. The galvanic current in the treatment of nasal hydrorrhea is mentioned by St. Clair Thomson⁽²⁾ in his text book, the source of his information being an article published by Cresswell Baber in 1898.

Intranasal zinc ionization has been employed by Fox⁽³⁾ for the postoperative treatment of the maxillary antrum, and by Hollender and Cottle⁽⁴⁾ for chronic rhinitis. Harris⁽⁵⁾, Feldman,⁽⁶⁾ Gale,⁽⁷⁾ Smith,⁽⁸⁾ Cahill,⁽⁹⁾ McCoy,⁽¹⁰⁾ Sputh,⁽¹¹⁾ McCurdy,⁽¹²⁾ and others have at one time or other reported on the use of zinc ionization in some forms of rhinitis and sinusitis.

Demetriades,⁽¹³⁾ and Franklin,⁽¹⁴⁾ have used this therapy in hay fever of the seasonal and perennial types, and Warwick⁽¹⁵⁾ only recently presented a paper dealing with its use in similar conditions.

Fundamental Aspects

The two fundamental laws upon which ionization is based are known as those of Faraday's, viz.:

1. The amount of any one substance liberated is proportional to the quantity of electricity which has traversed the cell (tissue between the electrodes).

2. Chemically equivalent quantities of ions are liberated by the passage of equal quantities of electricity.

Fabre Palaprat⁽¹⁶⁾ in 1883, and later Stephane Leduc,⁽¹⁷⁾ and Lewis Jones⁽¹⁸⁾ investigated the possibilities of ionization with

certain drugs and metals. While these authors presented no specific definition and withheld their views of the underlying basic principles, later writers freely expressed their opinions. One of these sources defines ionization as an arrangement by which a galvanic current is conducted to a body surface through suitable electrodes saturated with solutions of drugs or soluble metals. The "ions" are stated to be the result of decomposition of the substances in solution, and being electrically charged, they are capable of a superficial penetrating action in some of the body tissues, more particularly the mucous membranes.

There is a distinct difference in the present understanding of electrolysis and ionization as compared with that held by the older writers. In this connection Friel⁽¹⁹⁾ has pointed out that "by electrolysis in medical work we usually mean the changes which take place when a needle attached to one of the terminals of an electric battery is inserted in the tissues; and by ionization, the introduction into the tissues of one or other of the radicles of a salt dissolved in water."

Zinc sulphate, when dissolved in water changes to metallic zinc and SO_4 . The extent of the dissociation depends upon the dilution. For intranasal ionization, Friel's formula has been found best to meet the requirements. This consists of zinc sulphate 5 gms., glycerin 60 cc., and water to make 1,000 cc. For treatment this solution is diluted with an equal amount of warm water.

The amount of absorption of ions is proportionate to the strength of the current. In order to secure maximum effects, the current strength should be up to comfortable tolerance (usually about 10 ma.) and for a minimum application of 15 minutes. Recent observations have shown that an increased action results from longer treatment and maximum current, as against a fixed current strength and an arbitrary treatment period.

It is unfortunate that the term "ionization" has been used so loosely and inaccurately in an effort to label the procedure under discus-

sion. So many synonyms are used in the literature and are employed so interchangeably that the matter of terminology is in a state of confusion. All that can be said in justification of the general use of the term "ionization" is, that most writers have adopted it instead of a term which at once better designates the process and is all inclusive.

The numerous experiments cited by Friel,⁽²⁰⁾ Turrell,⁽²¹⁾ and others attempting to illustrate the electrical and physical phenomena involved will not be repeated here. While some of them are of interest, others are without practical application and the results are not conclusive. Contrary to the belief of years ago, it is now a matter of fundamental knowledge that the current generated by a battery of cells is one of negative electricity and that it has its source at the zinc plate. For therapeutic use, ions are classified as *anions* and *kations*, the former being introduced by the anode, the latter by the cathode. Copper and zinc belong to the kation group.

Therapeutics of Ionization

The process of ionization as now employed therapeutically must be considered as capable only of a superficial action on open surfaces and mucous membranes. The older belief that one is able to "drive in" drugs into the tissues through the skin is too fallacious for scientific consideration.

In ionization of mucous membranes tissue change is stimulated. It is quite likely that this change involves surface tissue penetration of an electrolytic substance. The depth of penetration of the various ions depends on several factors. Estimation of the quantity of an ion that will be introduced in any given period requires consideration of the electrochemical equivalent. This is the quantity, by weight, which is liberated by one ampere for one second, and this weight is in proportion to the chemical equivalents of the ions.

The action of zinc ions on the mucous membranes differs from that of the medicinal ions. In the case of the latter a soluble molecule is absorbed by the tissues, while in the former an insoluble precipitate is produced in the tissues. It is claimed that the effect of this precipitate is sterilizing or germicidal, depending upon the milliamperage or strength of the current and the duration of the flow.

During each treatment, the patient experiences a pronounced metallic taste and a profuse salivation. After the treatment one ob-

serves a greyish surface discoloration of the mucous membrane. This is probably a mild surface coagulation as the discoloration cannot be removed easily by rubbing. After the mucous secretions again become stimulated, the membrane gradually is restored to its original color. In addition to the local reaction all the symptoms of an acute coryza appear and persist for one to three days.

Technic and Apparatus

Various technics have been suggested for intranasal ionization. Friel⁽²²⁾ employed a small rubber balloon to block the postnasal space, in order to keep the nose full of the ionizing solution and at the same time prevent it from running down the throat. This method has several disadvantages, as a result of which Campbell⁽²³⁾ introduced his technic. Although rather complicated in nature, in his hands, it has operated successfully. This technic is carried out with the patient in the prone position. One nostril is plugged with plasticine and through this a Eustachian catheter insulated up to the proximal end is passed. Through the catheter the nasal chamber is filled with zinc solution, which, when flowing, will escape around the posterior end of the septum into and out of the opposite side of the nose. The active electrode is attached to the non-insulated proximal portion of the catheter and the current is turned on slowly up to 10 or 15 ma.

The simplest technic and one which operates satisfactorily in any cavity has been extensively employed by me⁽²⁴⁾ for the past ten years. It consists of packing the nasal chamber with long, narrow strips of gauze well moistened with zinc solution (Friel's formula). One should be cautious in covering all surfaces by introducing the gauze firmly high up, posteriorly, and in the middle and inferior meati. Before the treatment is started the membranes should be cleansed of secretions and crusts by suction, tampons, or irrigation with the same zinc solution used to moisten the gauze packing. The negative pole which is a felt pad of about 5x7 inches may be fastened around the forearm, or preferably to the nape of the neck. The patient is placed in a reclining position, with the head somewhat lower than the rest of the body. An insulated wire with a zinc fixation electrode is attached to the wet packing and held in position by some dry cotton packed into the

* Read before the Seminar of the Department of Laryngology, Rhinology and Otology, University of Illinois College of Medicine, Chicago, October 3, 1934.

meatus. This wire leads to the positive pole of a galvanic generator set or battery. Another insulated wire connects the moistened felt pad to the negative pole. With this arrangement the circuit is completed. The current is turned on very gradually and increased until the patient develops a metallic taste and profuse salivation. When the point of comfortable tolerance is reached, the current strength is maintained. If the meter indicates that the tolerance is at 10 ma. the treatment is continued for 15 minutes; if the reading shows 15 ma., the treatment is discontinued after 10 minutes. In the case of children and some adults, with a tolerance of about five milliamperes, the current should be maintained for 30 minutes. The plan is to give 150 milliamperes minutes, arrived at by multiplying the current strength in milliamperes by the minutes during which the treatment is continued. The suggested durations of treatments are rather arbitrarily based on experience, but a reasonable extension will occasionally prove of benefit. In fact, improved results were noted in many instances when the fixed treatment was even doubled.

Indications

In more than 1,000 ionization treatments during the past ten years, I have obtained good results in simple chronic rhinitis*, so-called "intumescent" or mild hypertrophic rhinitis, and in mild involvements of the anterior ethmoidal sinuses.⁽¹⁰⁾ It has also been shown to be a valuable postoperative aid,⁽²⁵⁾ especially when healing of the nasal membranes is for some reason delayed. Ionization of the antral mucosa is indicated after window resection when resolution does not occur as promptly as it should from a simple drainage. The improved results in such cases point to ionization as a definite advance in the therapy of maxillary sinus disease.⁽³⁾

Zinc ionization minimizes and frequently cures "postnasal discharge" when the source is strictly localized in the nasal mucosa. So many terms are used to designate nasal affections, the main symptom of which is "postnasal dripping," that no attempt can be made here to present detailed indications for ionization. Furthermore, the method has not yet passed the experimental stage, so far as extension of indications is concerned.

* There appears to be no standardized classification of rhinitis, but Phillips, St. Clair Thomson, and other authors support the classification employed here.

That zinc ionization is effective for shrinking polypoid tissue is supported by the experience of McCurdy.⁽¹²⁾ No claim can be made that this treatment yields permanent results, but it is advocated as a desirable temporizing measure when for some reasons surgery has to be deferred.

"Allergic Coryza"

Although I have employed zinc ionization in "allergic coryza" of the perennial type since I first attempted this physical procedure in 1923, I have never believed that in this condition it possessed more than a palliative effect. I still contend that its curative value remains to be determined. In four out of 10 patients treated by me two years ago, in three out of seven treated more than one year ago, and in nine out of a series of 15 during the current year, the symptoms of sneezing, lacrimation and stuffiness have been arrested. No supplementary therapy was given during the ionization treatments, the maximum number of which was four, and the average two, at weekly intervals. Several of the patients who responded had only a single treatment. (Table 1.)

In seasonal hay fever a lessening of the severity of symptoms is occasionally observed, providing the treatments are instituted prior to the hay fever season. In a series of 14 patients so treated during the 1933 season (summer and fall) no patient reported complete relief, but four were so relieved in comparison with previous years, that they found it unnecessary to use other palliative means. When, however, ionization was carried out during the acute attack, as it was in six cases, the immediate symptoms were greatly aggravated, necessitating the administration of anodynes. Subsequent relief was, however, experienced by three of these patients. (Table 2.)

Franklin⁽¹⁴⁾ treated 91 cases of hay fever, 14 of which underwent treatment before the following season. The average number of treatments in these 14 cases was six, at fortnightly intervals, and of these 11 had no attacks the next season, while three were not benefited. Of the 77 cases treated during the attacks, 51 were females and 26 were males, the ages ranging from 10 to 62 years. Of these, 54 had no further attacks, six were not benefited, and 11 failed to report. The majority of the patients received two or three

Table 1 — A Recent Series of Patients With Allergic Rhinitis (Perennial Type) Treated by Intranasal Ionization.

	Name	Sex	General Condition	Duration of Allergy	Year Treated	Type of Allergy	Previous Treatment	No. of Ionizations	Duration of Relief in Months	†Degree of Improvement	*Results with Electrolytes other than Zinc
1	J. W.	M.	?	1 yr.	1932	?	Nasal Surgery	2	32	††††	.....
2	E.R.G.	M.	Fair	5 yrs.	1932	Food	Desensitization	2	..	†	Neg.
3	L.S.	M.	?	2 yrs.	1932	?	Caut. of Turbs.	1	30	††††	.....
4	T.S.	F.	Good	1 yr.	1932	?	Nasal Surgery	1	..	†	Neg.
5	F.H.	M.	Good	2 yrs.	1932	?	None	3	..	††	No further change
6	H.G.	F.	Fair	5 yrs.	1932	House dust	Desensitization	2	30	††††	.....
7	L.W.E.	F.	Good	3 yrs.	1932	House dust (?)	Desensitization	4	..	†††	Neg.
8	R.T.	M.	Good	2 yrs.	1932	Food	Exclusion of Foods	1	..	†	Neg.
9	K.K.	M.	Fair	2 yrs.	1932	Furs	Change of Occupation	4	36	††††	.....
10	A.V.	F.	?	1 yr.	1932	?	None	2	..	o	Neg.
11	S.E.L.	M.	?	6 yrs.	1933	Horse Dander	None	2	19	††††	.....
12	R.V.	F.	Good	8 yrs.	1933	?	Various	1	16	††††	.....
13	W.S.	F.	Poor	2 yrs.	1933	?	Caut. of Turbs.	1	..	†††	Neg.
14	R.L.	F.	Poor	3 yrs.	1933	Food	Exclusion of Foods	1	..	†††	.....
15	J.E.W.	F.	Good	6 yrs.	1933	House dust	Various	2	..	†	Neg.
16	D.K.	M.	Fair	1 yr.	1933	Food	None	1	16	††††	.....
17	A.H.R.	M.	Fair	3 yrs.	1933	Food	Various	3	..	o	Neg.
18	E.R.	F.	Good	8 yrs.	1934	Furs	Various	4	8	††††	.....
19	S.R.	F.	Poor	2 yrs.	1934	House dust	Nasal Surgery	1	6	††††	.....
20	T.G.	M.	Fair	2 yrs.	1934	Physical (?)	Medical	2	..	††	No further change
21	E.L.S.	M.	Poor	4 yrs.	1934	Physical (?)	Medical	2	..	†	††† with copper
22	I.S.	M.	Good	1 yr.	1934	?	Medical	1	4	††††	.....
23	R.T.	M.	Poor	3 yrs.	1934	?	Various	2	9	††††	.....
24	N.R.	F.	Good	3 yrs.	1934	Furs	None	1	8	††††	.....
25	M.G.	M.	?	2 yrs.	1934	Wool	None	2	..	o	Neg.
26	J.H.	M.	?	1 yr.	1934	?	None	1	8	††††	.....
27	A.B.	F.	Poor	1 yr.	1934	?	Caut. of Turbs.	1	..	††	No further change
28	H.S.	M.	Good	6 yrs.	1934	?	None	2	5	o	Neg.
29	R.F.	M.	Good	3 yrs.	1934	?	Dietary	3	..	†	Neg.
30	B.H.	M.	Good	2 yrs.	1934	Food	Medical	1	4	†	Neg.
31	H.H.	F.	Poor	4 yrs.	1934	House dust	Desensitization	2	..	†	Neg.
32	E.S.H.	M.	?	8 yrs.	1934	House dust	Various	1	6	o	Neg.

*Degree of improvement noted as o = none; † slight; †† partial; ††† considerable; †††† complete arrest of symptoms.

treatments. Practically all of the patients presented severe symptoms and had previously undergone various types of therapy without benefit.

Franklin makes no comment of the discomfort suffered by seasonal hay fever patients when ionization is instituted during the acute stage. Irrespective of the technic employed, the possible benefits from such therapy are far overshadowed by the increased severity of the immediate and subsequent symptoms characteristic of the seasonal type of hay fever.

Of the 12 cases of vasomotor rhinitis treated by Franklin, only two were definitely relieved. Of the remaining 10, four were improved after six months, and the other six

discontinued their treatments because their condition was not benefited. These findings are in direct contrast to mine, for I have found intranasal zinc ionization more beneficial in vasomotor rhinitis than in the seasonal affection.

Unusual caution must be exercised in treating an "allergic nose" because of the sensitiveness of the mucosa and the likely harmful effect of the slightest trauma. Only occasionally is it necessary to resort to preliminary anesthesia, a step which, for obvious reasons, should be avoided if possible.

For the evaluation of zinc ionization in the conditions for which this treatment appeared indicated, I made use of control patients. In these, zinc solution was applied topically to

Table 2 — A Series of Patients With Hay Fever (spring and fall Types) Treated by Intranasal Ionization During the Year 1933.

Name	Sex	Duration of Disease	Spring or Fall Type	Previous Treatment	No. of Ionization Treatments	Prior to or During Onset of Symptoms	Immediate Reaction	Ultimate Result	Condition During Hay Fever Season of 1934
1 W.R.	M.	14 yrs.	fall	Palliative remedies	2	prior	mild	No relief	.....
2 M.J.	M.	6 yrs.	fall	Ragweed Desens.	2	prior	none	No relief	.....
3 E.E.S.	M.	3 yrs.	spring	None	1	during	severe	Marked relief	No severe discomfort
4 C.L.	F.	8 yrs.	fall	Ragweed Desens.	1	during	severe	Slight relief	Severe symptoms
5 R.O.	M.	2 yrs.	fall	Ragweed Desens.	1	during	severe	Marked relief	Practically no symptoms
6 R.E.W.	F.	15 yrs.	spring	Palliative remedies	1	during	severe	Marked relief	Practically no symptoms
7 H.K.	M.	20 yrs.	fall	Change of environ't	3	prior	none	No relief	.....
8 S.S.H.	F.	9 yrs.	fall	Change of environ't	1	during	severe	Marked relief	Slight discomfort
9 J.C.	F.	4 yrs.	spring	Nasal surgery	2	prior	none	No relief	.....
10 B.H.	F.	4 yrs.	spring	Medical	4	prior	none	No relief	.....
11 A.R.C.	M.	6 yrs.	fall	Ragweed Desens.	1	during	severe	Fair relief	Severe symptoms
12 W.E.B.	M.	2 yrs.	fall	None	1	prior	none	No relief	.....
13 H.R.	F.	3 yrs.	fall	None	2	prior	none	Fair relief	Severe symptoms
14 S.K.	M.	18 yrs.	fall	Various treatments	4	prior	severe	No relief	.....

the nasal mucosa by tampon for periods varying from 15 to 40 minutes, in the same manner as employed for ionization, but without the use of the galvanic current. The results were negative in every instance. As this control procedure was performed in more than 100 patients presenting various indications for intranasal ionization, it is logical to deduce that the galvanic current and the ionization process are accountable for the therapeutic effects.

It should be added here, that in my experimental work with intranasal ionization, various compounds of zinc were employed for the electrolytic solution. Copper compounds also were experimented with and were found to be satisfactory when utilized in very weak solution (copper sulphate 1/5 of 1 per cent). In no instance, however, where solutions other than zinc sulphate were employed for the electrolyte, did the results warrant such a change. My observations are at variance with those of other rhinologists^{(15), (26)} who recently have claimed that the addition of cadmium and tin to the zinc solution makes an improved electrolyte for ionization.

Comment

The use of the galvanic current in rhinology is not new. The earliest reference in the lit-

erature, as previously mentioned, is that of Baber's, published in 1898. Since then, various physical intranasal procedures have been employed with a view of favorably affecting the pathologic processes in the different types of chronic rhinitis. Efforts are usually directed towards the inferior turbinates, for apart from the histological alterations, inspection reveals a structural increase, interfering with normal ventilation and drainage of the nose and its accessory sinuses. Reference already has been made to zinc electrolysis of the inferior turbinates, while the actual cautery⁽²⁷⁾ is commonly suggested for reducing these nasal structures. More recently medical diathermy,⁽²⁸⁾ and electrosurgery,⁽²⁹⁾ have been advocated as effective methods.

Zinc ionization appears to have a more pronounced effect than any of the above procedures, its recent extensive use by rhinologists having brought this treatment prominently to the attention of the medical profession.

In simple chronic rhinitis⁽³⁰⁾ the value of ionization cannot be doubted, as experience has demonstrated a rather large percentage of patients to have been improved by this treatment. In chronic sinusitis,⁽³¹⁾ under certain conditions, the method likewise is of pronounced benefit. Whether or not the "aller-

gic nose" can be influenced permanently, remains a problem for continued investigation. While ionization has arrested the symptoms of allergy in some patients, sufficient time has not elapsed, nor has a sufficiently large number of patients been treated to justify a positive report. Zinc ionization being a strictly local measure, it obviously cannot influence the systemic or intrinsic factors underlying any of the allergic nasal affections.

Conclusions

1. Zinc electrolysis of the inferior turbinates was first described by Baber in 1898, but since then the treatment has been used only irregularly.

2. Zinc ionization, a modification of zinc electrolysis, has been successfully employed by the author during more than ten years for intumescent rhinitis and for some forms of sinusitis.

3. Intranasal ionization can be performed with simple and inexpensive apparatus. Solutions other than those of zinc sulphate have not been found to be superior electrolytes, nor have they produced improved results.

4. The method is now being tried extensively for seasonal and perennial hay fever. In the former the author's experience has not been as favorable as that of other rhinologists; in the latter it has been encouraging enough to warrant further trial.

5. That the procedure definitely possesses merit in nasal cases other than those of an allergic nature has been established.

30 North Michigan Avenue.

References

- Norrie, F. H. B.: Enlarged Turbinates: Treatment by Zinc Electrolysis, *J. Laryng. & Otol.* 41:87 (Feb.) 1926.
- Ionization and Electrolysis in the Nasal Cavities, *J. Laryng. & Otol.* 42:674 (Oct.) 1927.
- Thomson, Sir St. Clair: Diseases of the Nose and Throat, New York, D. Appleton & Company, 1927.
- Fox, Mearle C.: The Postoperative Treatment of the Maxillary Sinus by the Ionizing of Zinc, *Northwest Med.* 23:82 (Feb.) 1924.
- Hollender, A. R., and Cottle, M. H.: Recent Advances in the Treatment of Nasal Accessory Sinus Disease, *Eye, Ear, Nose and Throat Monthly* 5:575 (March) 1926.
- Physical Therapy in Diseases of the Eye, Ear, Nose and Throat, New York, The Macmillan Company, 1926.
- Harris, M. L.: Zinc Ionization as a Treatment for Intermittent Nasal Obstruction, *Arch. Otolaryng.* 10:75 (July) 1926.

- Feldman, Louis: A Rational Treatment of Hypertrophic Rhinitis, *New England J. Med.* 198:682 (May 17) 1928.
- Gale, Jos.: Zinc Ionization in the Treatment of Intumescent Rhinitis, *Arch. Phys. Therap., X-Ray, Rad.* 10:486 (Nov.) 1929.
- Smith, Ferris: Asthma: Its Etiology and Surgical Treatment, *Ann. Otol., Rhin. & Laryng.* 38:1095 (Dec.) 1929.
- Cahill, A. J.: Electric Ionization in Otorhinology, *Eye, Ear, Nose and Throat Monthly* 12:59 (March) 1929.
- McCoy, John: Zinc Ionization of the Etmoids, *Laryngoscope* 40:640 (Sept.) 1930.
- Spath, Carl B.: Zinc Ionization in the Treatment of Rhinitis and Nasal Accessory Sinusitis, *J. Indiana M. A.* 24:461 (Sept.) 1931.
- McCurdy, Gordon J.: Electric Ionization in Otorhinology, *The Rhode Island M. J.* 14: 151 (Oct.) 1931.
- Demetriades, T. D.: Zur Behandlung der Vasomotorischen Störungen der Nase durch Iontophorese, *Archiv. f. Nasen, Hals und Ohrenheilkunde, Monatschr. f. Ohrenh.* 61:524 (May-June) 1927.
- Franklin, P.: Treatment of Hay Fever by Intranasal Zinc Ionization, *Brit. M. J.* 367:1115 (June 27) 1931.
- Intranasal Treatment by Ionization in Hay Fever, *Vasomotor Rhinitis and Ozaena. Brit. M. J.* 1:751 (April 23) 1932.
- Warwick, Harold L.: Treatment of Hay Fever and its Allied Conditions by Ionization: Preliminary Report, *Laryngoscope* 44:173 (March) 1934.
- Palaprat, Fabre: Quoted by Cross in "Electrotherapy and Ionic Medication," Philadelphia, J. B. Lippincott Company, 1925.
- Leduc, Stephane, (Translation by R. W. MacKenna): Electric Ions and Their Uses in Medicine, London, Rebman Limited, 1913.
- Jone, Lewis H.: Ionic Medication, London, H. K. Lewis, 1913.
- Friel, A. R.: Zinc Ionization and Zinc Electrolysis in the Treatment of Chronic Otorrhea, *Am. J. Electrotherap. & Radiol.* 39:414 (Oct.) 1921.
- Friel, A. R.: Notes on Chronic Otorrhea, New York, William Wood and Company, 1929.
- Turrell, W. J.: The Principles of Electrotherapy and their Practical Application, New York and London, Oxford University Press, 1922.
- Friel, A. R.: Zinc Ionization in the Treatment of Suppuration of the Maxillary, Sphenoid and Frontal Sinuses, *Brit. M. J.* 2:204 (Sept. 10) 1921.
- Treatment of Sepsis in Nose and Ear by Ionization, *Practitioner.* 103:449 (Dec.) 1919.
- Campbell, A.: Ionization in Nose: New Technic, *J. Laryng. and Otol.* 43:98 (Feb.) 1928.
- Hollender, A. R.: Chronic Rhinitis, *Arch. Phys. Therap., X-ray, Rad.* 10:27 (Jan.) 1929.
- Hollender, A. R.: Postoperative Physical Aids in Otolaryngology, *Arch. Phys. Therap. X-Ray, Rad.* 12:19 (Jan.) 1931.

26. Haseltine, Burton: Ionization in the Treatment of Nasal Hyperesthesia, Eye, Ear, Nose and Throat Monthly 13:257 (Aug.) 1934.

27. Jackson C., and Coates, G. M.: Diseases of the Nose, Throat and Ear. Philadelphia, W. B. Saunders and Company, 1929.

28. Hollender, A. R.: Physical Measures in Hypertrophic Rhinitis, Illinois M. J. 64:269 (Sept.) 1933.

29. Beck, J. C.: Pathology and Intramural

Coagulation of the Inferior Turbinate. Ann. Otol., Rhin. & Laryng. 39:349 (June) 1930.

30. Hollender, A. R.: Chronic Suppurative Otitis Media, Chronic Maxillary Sinusitis, Simple Chronic Laryngitis, Arch. Phys. Therap., X-Ray, Rad. 10:503 (Nov.) 1929.

31. Hollender, A. R., and Cottle, M. H.: Nasal Accessory Sinus Disease: A Survey of Available Treatment Methods with Special Reference to Physical Therapy, Illinois M. J. 52:106 (Aug.) 1927.

Intranasal Zinc Ionization — Its Fundamental Aspects and Clinical Value

A. R. HOLLENDER, M.D., F.A.C.S.

CHICAGO

Reprinted from the
Archives of Physical Therapy, X-Ray, Radium,
October, 1934, Vol. XV, pp. 581-587